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Preliminary study of the missing mass spectra via the $^{12}C(p, K^0_s)$ and $^{12}C(p, \Lambda)$ reactions at 10 GeV/c.

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Abstract The missing mass spectra for the $^{12}C(p, K^0_s)$ and $^{12}C(p, \Lambda)$ reactions have been studied by using of the propane bubble chamber(PBC) data from 700000 stereo photographs or 10^6 inelastic interactions. The momentum spectrum of π^- in range of 100-200 MeV/c have observed the significant enhancement from the p+C$\rightarrow$ $\pi^-\Lambda$X(p+C$\rightarrow$ $\pi^- K^0_s$X) reaction. The missing mass spectra have been observed signals for the $p(p, \pi^- K^0_s)$, $^3H(p, pK^0_s)$, p(p,$\Lambda)\pi^-\gamma$ and p(p,$\pi^-)\Lambda$ reactions. This experimental study will need to continue by a different method of identification for a reaction channels.

Keywords hyperon · hypernucleus · strangeness · 4π geometry

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1 Introduction

The properties of hypernuclei reflect the nature of the underlying baryon-baryon interactions and, thus, can provide tests of models for the free-space hyperon-nucleon (Y,N) and hyperon-hyperon (Y,Y) interactions[1]. The missing mass(MM) method makes it possible to obtain unique information on the masses and the structure nuclei. The possibility to produce hypernuclei in the (p,K^+) reaction was firstly mentioned by [2].In fact, the recent studies on the (p ,K^+) reaction confirm a quite substantial production of associated Λ-hyperons leading to production cross sections for Λ-hypernuclei in the order of a few 100 μb for p + Pb at 1.5 - 1.9 GeV[3]. The paper presents the preliminary experimental results from the MM spectra in p+C interactions[4]. This analysis with the MM is the first step to explore hadronic systems with strangeness.The event by event analysis will be the next step.

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2 Experimental data

The events with V^0 (Λ and K_s^0) were identified by using the criteria[5]. The mass of the identified 9838-events with Λ hyperon and 4964-events with K_s^0 mesons is consistent with their PDG values. The FRTIIOF model and experimental data comparison shown that there are observed significant enhancement for Λ hyperons production in ranges of the scattering $\theta < 0$ and azimuth $\phi \approx 0$ angles [4] in the spherical system of coordinates. The missing mass error is equal to $\approx$ 80-100 MeV/c^2 for the p(p,K_s^0) and p(p,Λ) reactions.

3 The missing mass spectra with K_s^0 meson

Fig. 1,a shows the missing mass(MM) spectrum for 3428 events in the p(p,$K_s^0\pi^-$) reaction with a bin size of 34 MeV/c^2. The curve(Fig. 1,a is the sum of the background by the 9 order polynomial and 1 Breit-Wigner function. The peaks in the MM range of 3.35 GeV/c^2 with $\Gamma_{exp} \approx$ 90 MeV/c^2, S.D.(statistical deviation)5.7σ($\approx$ 90 events in peak) and $\approx$ 3.00 GeV/c^2 with S.D.= 4.5σ ($\approx$40-50 events in peak.) have been observed.

Fig. 1,b shows the MM spectrum for p(p,K_s^0p) reaction (7150 events) with a bin size of 44 MeV/c^2. There are observed signals in the MM range of 1020, 2050 and 2580 MeV/c^2, with S.D.$\approx 4\sigma$[4]. A signal is not observed in the MM spectrum for the p(p,K_s^0p) reaction by FRITIOF model. Fig. 1,c shows the MM spectrum for 11118 events in the ^3H(p,K_s^0 p) reaction with a bin size of 40 MeV/c^2. The curve(Fig. 1,c) is the sum of the background by the 9 order polynomial and 1 Breit-Wigner function. There is observed signal in mass range of ${}^6_\Lambda He$(5.78 GeV/c^2) with Γ=90 MeV/c^2, S.D.=5.7σ(120-150 events in the peak). Fig. 2,a shows the MM spectrum for 4148 events in the ^3H(p,K_s^0 p)(with π^- events) reaction with a bin size of 40 MeV/c^2. The same peak in the mass range of 5.8 GeV/c^2 (${}^6_\Lambda He$) have been observed. There is also the significant enhancement in the MM range of 5.6 GeV/c^2 (interpreted as ^6He).

4 The missing mass spectra with Λ hyperon

Fig. 2,b shows the momentum distribution for π^- with a bin size of 33 MeV/c for $^{12}C(p,\Lambda)$reaction. The fluctuation is observed in the momentum range of 100-200 MeV/c. The 9-order polynomial did not describe the momentum distribution for π^- in Fig. 2,b.

Fig. 2,c shows the MM spectrum for the p(p,π^-) reaction (for events with Λ) with a bin size of 30 MeV/c^2. The background is the 9-order polynomial function. The peak in the MM range of 4200 MeV/c^2 with S.D.= 3.8σ have been observed. There are observed small signals in the MM ranges of ${}^4_2He$(3.8 GeV/c^2) and ${}^4_\Lambda He$(3.9 GeV/c^2)(Fig. 2,c).

Fig. 2,d shows the MM spectrum for the p(p,Λ) reaction (with $\pi^- and \gamma$ events) with a bin size of 41 MeV/c^2. The background is the 9-order polynomial

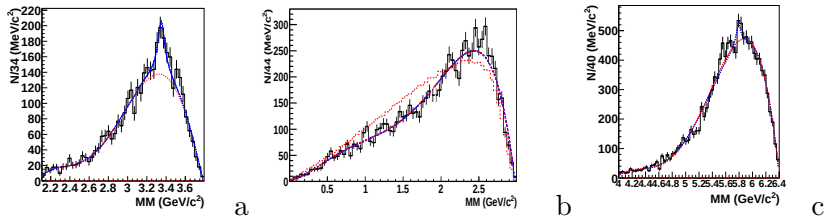
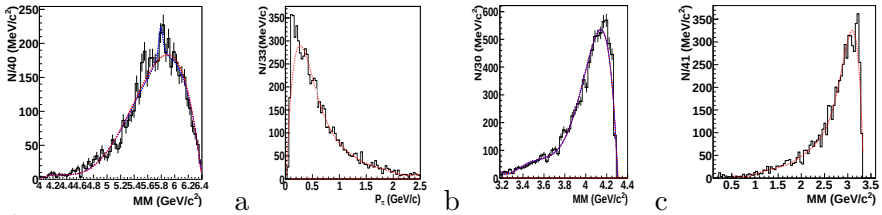


Fig. 1 a)The missing mass spectrum(MM) of the (p,$K^0_s\pi^-$) reaction. b)The MM spectrum for the p(p,$K^0_s p$) reaction (7150 events). The dashed histogram is simulation by FRITIOF model. c)The MM spectrum for the ^3H(p,K^0_s p) reaction(11118 events).



d

Fig. 2 a)The MM spectrum for the ^3H(p,K^0_s p) reaction (with π^-,4148 events). b)The momentum distribution for π^- in the p+C$\rightarrow \Lambda\pi^-$ X reaction. c)The MM spectrum for the p(p,π^-) reaction (with Λ, 7400 events). d)The MM spectrum for the p(p,Λ) reaction (with π^-, γ, 5659 events).

function. The peak in MM range of 3200 MeV/c^2 with Γ_{exp} ≈90 MeV/c^2, S.D.= 6σ have been observed. The same peak is observed from this data in[5] and OBELIX data in[6], what had been interpreted as S=-1 tribaryon states.

5 Conclusion

The signals in the MM spectra have been observed only a few possible channels from these $^{12}C(p, K^0_s)$ and $^{12}C(p, \Lambda)$ reactions. These signals for the same reactions have observed with π^- events too. The momentum spectrum of π^- in range of 100-200 MeV/c from the p+C$\rightarrow \pi^-\Lambda$X(p+C$\rightarrow \pi^- K^0_s$X) reactions have observed the significant enhancement(Fig.2,b). Then the event-by-event analysis of $^{12}C(p, K^0_s)$ and $^{12}C(p, \Lambda)$ collisions will the next step what allow identify a channel of reactions by kinematic fits for different hypothesis.

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